ReMAP Task Force Meeting Agendas and Minutes

Meeting #1 Agenda and Minutes

April 2-3, 2002

Tuesday, April 2, 2002

Location: NASA Headquarters
300E St. SW
Washington, DC 20546
Room: 7H46 (MIC 7)

10:00-10:15	Review of Agenda	Silver/Shirley Lee
10:15-11:00	NASA Administrator Address	O'Keefe
11:00-11:30	Ethics	Rafferty
11:30-12:00	Charter to the Task Force	Kicza
12:00-1:00	Working Lunch	
12:30-12:45	Logistics Reminder	Stevens
1:00-2:00	OBPR Research Program Overview	Trinh
2:00-3:30	OBPR Research Issues	Fogleman Liskowsky Trinh Uhran
3:30-5:00	Committee Deliberation	
5:00	Adjourn	
6:00	Social Dinner at 701 Restaurant 701 Pennsylvania Ave, NW Washington, DC 20004 202-393-0701 $32 inclusive	

Minutes: Tuesday, April 2, 2002

Dr. Rae Silver, Chair of the ReMAP, called the meeting to order and Dr. Mark Lee, Executive Secretary, made logistics announcements and reviewed the schedule and agenda. He noted that during the meeting, members should notify him "real-time" of any potential conflicts of interest. Dr. Silver indicated that this committee would be using material from previous reports in their deliberations. The purpose of the first meeting is to provide the members with an overview of the Office of Biological and Physical Research (OBPR) research and background, current prioritizations, and budget. The next meeting in April will be spent on more detailed information gathering and discussion on how the research might be prioritized, including mechanisms for making decisions. The third meeting will be focused on integrating the findings and writing the report. In response to a question regarding metrics, Dr. Trinh noted that the staff at HQ has put together a set of straw man priority criteria, as well as a process and implementation plan, for the Task Force to review, discuss, recommend, and adopt.

NASA Administrator Address

After introduction of members, Mr. Sean O'Keefe, NASA Administrator, addressed the Task Force. He thanked the members for their willingness to participate in the ReMAP activity. From the International Space Station (ISS) Management and Cost Evaluation (IMCE) report, there was a clear directive: that NASA establish a clear prioritization for science objectives and research opportunities. Mr. O'Keefe asked that the Task Force focus on what the science and research priorities should be, rather than how they should be accomplished. The science and research priorities should be the driving requirements on the ISS. He asked that the Task Force concentrate on two things: (1) those science and research objectives that could only be accomplished with this unique capability; and (2) what would provide the highest payoff or yield, i.e., what is worthy of this capability and would inform a wider degree of applications, e.g., a breakthrough understanding in some field. Other constraining factors (mass, power, crew time, orbiter flight rates, etc.) should be set aside and left as issues for NASA to address. The opportunity to get a preliminary assessment from this activity by early summer will inform a series of decisions that must be made by late summer. Mr. O'Keefe stated that the first critical step is a clear establishment of what the requirements are, i.e., the prioritized science and research objectives. It is the basis on which the ISS capability is being established. Mr. Fred Gregory challenged the Task Force to give NASA some "stretch goals" to drive the next configuration. The next step could be a larger station or something else. The last issue that Mr. O'Keefe touched upon was the on-going revision to Agency mission objectives. He asked that the Task Force get a briefing from Ms. Mary Kicza, Associate Administrator for OBPR, on the preliminary findings. The Task Force output will help guide that debate. In response to a question, Mr. O'Keefe indicated that the Task Force should not restrict its deliberations solely to objectives related to long-term exploration of space. This has been a dominant viewpoint, but this should not be responsible for the exclusion of science and research objectives that could inform advances on Earth. Although the Young panel addressed the ISS mission, it primarily focused on the ISS configuration. This ReMAP exercise does not focus on the configuration or budget. Its objective has a different set of parameters—it is a science and research driven exercise.

In response to a comment regarding the ISS mission of "use" and "exploration," Mr. O'Keefe indicated that the Task Force should hear about the exciting Agency objectives from Ms. Kicza. This new Agency approach is more selective and focused; it excludes a number of objectives that could be accomplished by other entities and starts to address the fundamentals of what the Agency can do. With respect to the scope of the Task Force, it will be the task of Dr. Shannon Lucid (NASA's recently appointed Chief Scientist) to merge the other stakeholders' (Earth Science, Space Science, Office of Space Flight and Aerospace Technology) interests.

Ethics

Ms. Laurie Rafferty, Senior Ethics Attorney at NASA Headquarters, provided the required ethics briefing to members of the Task Force. The ReMAP Task Force is constituted as part of, and reports through, the NASA Advisory Council (NAC). Legally, this meeting is a non-Federal Advisory Committee Act (FACA) meeting and is not required to be open; however, NASA has chosen to have an open meeting, with closed deliberation sessions or other closed discussion sessions as required. Ms. Rafferty explained the financial conflicts and post-employment restrictions statutes on the Task Force members, who are Special Government Employees (SGEs) for the duration of the activity. Ms. Rafferty suggested that if there are any questions about the applicability of the statutes, the members should contact the General Counsel's office. Although post-employment restrictions apply to SGEs, most advisory committee members are not personally and substantially involved in particular matters, e.g., selection of grants, as part of their government service. All of these statutes require participation in a particular matter to trigger restriction. For the normal scope and charter of advisory committees, general advice and recommendations on a program is not sufficient to trigger statutes. Ms. Rafferty encouraged the Task Force to get advice in advance whenever possible, and she provided a list of contacts in the General Counsel office for any questions related to these statutes.

Charter to the Task Force

Ms. Kicza reviewed the Task Force terms of reference. As noted by Mr. O'Keefe, the IMCE was one of the drivers for this activity. In addition, the OSTP asked NASA to engage the scientific community in this activity. NAC recommended that NASA establish scientific research priorities and develop an executable program. In consultation with OSTP and OMB, OBPR assembled the ad-hoc external advisory committee, the ReMAP, to assist OBPR in establishing a prioritized program for its research portfolio. Ms. Kicza indicated that the program that the OBPR would lay out is within the President's budget request. However, the Administrator has said that the Task Force should not allow the constraints to dictate the priorities. The charter for the task force is to produce a final report that will focus specifically on the following: (1) evaluate and validate the high priority science and technology research to be funded by OBPR to maximize the research return within the available resources; (2) evaluate the major thrust areas and key research objectives for OBPR with an emphasis on establishing the research content for the ISS US Core Complete configuration; (3) recommend ways to increase scientific productivity; (4) recommend criteria that can be used to implement specific research activities, based on priorities; and (5) identify areas

for priority consultation with the International Partners (IPs). In response to a question, Mr. Kicza indicated that the NRC is in the business of establishing the long-term research priorities. The research priorities tend to be strategic in nature and look more dominantly at the long term. In OBPR, there are a broad variety of reports that are strategic in nature and do not address the immediate tactical priorities. This Task Force can help integrate the tactical priorities, keeping in mind the long-term priorities that have been enunciated in the external reports. OBPR has a broad set of research disciplines, and the research bodies that represent those disciplines do not tend to integrate across the broad spectrum. The Task Force can help integrate the disparate groups of recommendations into a tactical set of priorities. A draft integrated set of priorities has been developed to give the Task Force the benefit of the OBPR perspective and to have something to start to work with. OBPR looks forward to iterating the options within the context discussed by Mr. O'Keefe. With respect to assessment of research content options, Ms. Kicza stated that the Task Force should understand reality, but not be shackled by the constraints of the budget or core complete. NASA needs to gain perspective on how to proceed beyond core complete.

Closed Session

During lunchtime, the Task Force held a closed session meeting.

OBPR Research Program Overview

When the meeting continued, Dr. Eugene Trinh, Director of the Physical Sciences Research Division, provided an overview of current ground-based and flight R&D programs and plans. OBPR currently has a balanced research portfolio that that can be divided into three primary research areas: multi-disciplinary fundamental research enabled by access to the space environment; basic and applied research laying the foundation for long-term human space exploration; and applied research uniquely enabled by the space environment and positively impacting the quality of life on Earth. Dr. Trinh recounted some of the recent OBPR research contributions and highlights and showed the distribution of FY02 research awards. With respect to the President's Budget, the budget "gap" is driving the re-prioritization of research. Historically, funds have been taken out of the research program (a total of four times) to cure problems in ISS development. Dr. Trinh discussed the FY03 President's Budget Submit and described the research planning process. The near term actions include: reprioritization of the research program for the restructured ISS (the ReMAP activity); establishment of an aligned budget supporting the reprioritized program; pursuit of options to evolve the program beyond core complete; and notification of the research community and consultation with the IPs.

Dr. Trinh described the content of the research within each of the three thrusts: (1) fundamental research; (2) human space exploration research; and (3) research targeting Earth-based applications. In response to a question, he indicated that about 90% of the U.S. allocation of internal, pressurized volume will be used by OBPR. There are several options to maximize the impact of ISS, e.g., emphasizing a single thrust. OBPR recommends maintaining a dynamic balance between the three primary thrusts. This retains the ability to adapt the program to changing ISS resources and to evolve the

program beyond US core-complete. It also maintains a broad supportive constituency, allows more flexibility to maximize ISS research impact, and enables basic research to develop the knowledge base for exploration. Dr. Trinh described the evolution of the OBPR organization. In response to a question, Dr. Trinh indicated that the funds to build the racks have been included in the FY02 budget. Research (grants) and research capability (hardware and facilities) are now both included in OBPR's budget.

OBPR Research Issues

Dr. Guy Fogleman, Acting Director of the Bioastronautics Research Division, discussed the issues and the mission. Within Bioastronautics, there are two major areas—the biomedical area, including countermeasures, and the advanced human support technologies area. Bioastronautics research is focused research and is mission driven. The content has been defined and prioritized in consultation with the science community, national advisory groups, and NASA's medical operations personnel. The most critical research questions are addressed in a "Critical Path Roadmap." The program has produced a number of countermeasures to protect the crew from the deleterious effects of space flight. In addition, this research has produced useful end products for NASA that have Earth benefits. High priority research problems have been identified in the Critical Path Roadmap. The Task Force asked for a correlation between the research areas and the "boxes" under the three major thrusts discussed by Dr. Trinh. Dr. Fogleman showed the risk/priority ranking within each discipline and described the countermeasure development process. Bioastronautics research has impact on making the ISS a useful research facility. In addition, there is specific bioastronautics research that supports the exploration goal, the fundamental science goal, and the Earth-based applications goal. In response to a question, Dr. Fogleman indicated that a lot of bioastronautics research is ground-based; however, some of the research can only be done in space, e.g., human factors research. Over the last year, about 8 experiments out of 250 have been conducted in space; the same is expected for next year. Many of the 250 are waiting for flight. For the long-duration platform, more are expected. Dr. Silver asked for a list of the high-priority science questions that Dr. Fogleman would like to see addressed that are not being addressed on ISS. What issues must be addressed on ISS?

Dr. David Liskowsky, Acting Director of the Fundamental Space Biology Division, provided a high level overview of the Division and the primary focus of the research. The main focus of the program is to understand biological systems and processes in the context of the space flight environment, particularly microgravity. The research program is an integrated program of both ground-based and flight-based activity. Content has been prioritized in consultation with the science community and national advisory groups. The program has two key research objectives: (1) to determine the consequences of adaptation to space; and (2) to use the unique characteristics of the space environment as a tool to understand biological processes on Earth and in space. Dr. Liskowsky highlighted five key research questions that will achieve these objectives. In order to answer these questions, the program is divided into six research elements. It involves the study of biological systems at all levels of complexity. A full range of specimen models is essential. Dr. Liskowsky showed the types of research that fall within the three thrusts described earlier. Currently, there are 175 principal investigators

(PIs). Of these, 32 are flight PIs; 9 of these are candidates for ISS. Delivery of FSB hardware to ISS is not planned to occur until the 2005-2006 timeframe. In response to a question, Dr. Liskowsky showed the distribution of the R&T budget in 2001 and the budget changes (before and after cuts) in the Fundamental Space Biology ISS budget (FY01 through FY07). In response to a question, he described the hardware initially planned for ISS. The US was to build the habitat holding racks, the cell culture unit, the plant habitat, the rodent habitat, and an incubator. Under the core complete budget, there are 2 habitat holding racks, the incubator, the cell culture unit, and some supporting software. The decision to go forward with the cell culture unit rather the plant and rodent habitats were driven by the fact that the cell culture unit had less cost to complete and it was the most automated piece of equipment. The current budget does not support building the initial rodent and plant habitats. NASA would like to buy back the habitats as resources permit. There is close connection between fundamental space biology and bioastronautics. Dr. Pawelczyk requested more budget detail on the scaled back facilities.

Dr. Trinh discussed the Physical Sciences Program. The goal is to significantly advance scientific knowledge and technological applications by focusing on and controlling gravitational effects. One of the highest payoffs is to be able to resolve fundamental aspects in major industrial processes. Dr. Trinh showed the research elements under the three major thrust areas. About 45% is under fundamental research. The Physical Sciences Program is currently operating ISS investigations in multi-user facilities and plans to deploy a dedicated research facility starting in 2004. In addition, the Program is developing an integrated Biotechnology Research Facility. Currently, the Program has 468 investigators funded to carryout 549 different research tasks. Eighty-five 85 ISS flight investigations are planned for implementation between 2002 and 2008. Dr. Osborn questioned why the biological efforts noted by Dr. Trinh are included in his program rather than the Fundamental Biology Program and how advice to each program is integrated. Dr. Trinh stated that the Physical Sciences Program provides the fundamental tools and knowledge base. If the questions are driven by gravitational influence, the Physics Sciences Program is looking at the fundamental mechanism. The Program participates in various working groups (NSF, NIH). Dr. Trinh showed the distribution of the R&T funding among the disciplines as well as the total funding for each of the thrust areas (both grant and ISS research capabilities development).

Mr. Mark Uhran, Director of the Research Integration Division, discussed the commercial space research program. The objective of space product development is to demonstrate the competitive advantage of the space environment to U.S. industry. Specific R&D investment criteria are used to select the projects. This program does not aim to produce products in space; it is aimed at using insights gained in the unique environment of space to foster new or improved products and services on Earth. The fields of commercial research are varied and include biotechnology, agribusiness, and materials processing. Commercial Space Centers (CSCs) are non-profit organizations that lead consortia of commercial, academic, and/or government entities in space research and development projects. They are established by cooperative agreements with NASA and provide an interface to industry. There are a number of metrics that are used to

manage the program. [These are included in the annual report, distributed to Task Force members.] Mr. Uhran showed the ratio of NASA and non-NASA funding to CSCs and highlighted some representative product lines for ISS. Over 60 product lines are in development. About three-fourths of these are ground-based. The rate-limiting factors are access to space and duration of time on orbit. Advanced engineering technology development is a diverse and burgeoning market. About 4 projects in these areas are on going. Mr. Uhran briefly reviewed the CSC program history. NASA is preparing to enter a third cycle of external reviews. Projects turn over on a regular basis. This Program represents about 5% of the total OBPR budget, and it is being further challenged to reduce the level to about 3%. Mr. Uhran encouraged the Task Force members to talk to the Center Directors directly about the program, as well as the industrial affiliates. In response to a question, Mr. Uhran noted that NASA selects research that has the highest ratio of private to public investment. He described how CSC's are selected and established.

Closed Session

The Task Force held a closed session meeting at this time.

Wednesday, April 3, 2002
Location: NASA Headquarters
300E St. SW
Washington, DC 20546
Room: 7H46 (MIC 7)

8:00-9:00	IMCE Overview	Young/Hedin
9:00-10:00	International Space Station Overview/ US Core Complete Option	Hedin
10:00-10:15	Break	
10:15-11:15	ISS Resources and Accommodations	Uhran
11:15-12:15	Research Prioritization Criteria and Prioritization Process – Part I	Clinton
12:15-1:00	Working Lunch	
1:00-2:00	Research Prioritization Criteria and Prioritization Process – Part II	All
2:00-3:00	Committee Deliberation	
3:00	Adjourn	
3:00-4:00	Meeting with House Science Committee Staff	Silver Shirley Kicza

Minutes: Wednesday, April 3, 2002

International Space Station (ISS) Overview/US Core Complete Option
Mr. Dan Hedin provided an overview on the ISS and core complete. ISS is about exploration, research, commercialization, international leadership, and education. It supports the long-term goals in exploration as well as providing a unique research facility in space. Mr. Hedin showed the comparison of the US core complete station with Mir, Spacelab, and Skylab and described the "core complete" configuration that is consistent with the President's FY03 budget. In response to a question, Mr. Hedin indicated that with only 3 crew, it will be a challenge to provide 20 hours crew time for utilization. The US "piece" of this is about 7.5 hours. In addition, NASA is purchasing Russian crew time, bringing the US total to approximately 10 hours. The other limiting factor is

logistics. Ms. Kicza asked the Task Force to consider core complete as a milestone. The Task Force efforts will help guide the Program beyond that milestone. Dr. Silver added that the Task Force should spend the bulk of its time thinking beyond core complete. All partners have a role in management. One of the IMCE issues was the non-concurrence of the IPs on the assembly sequence; "core complete" was not a recognized milestone. Mr. Hedin described the current functionality and capabilities. In the FY03 budget, the Program went to 4 flights per year, which stretches out the assembly schedule slightly. US core complete occurs in the early 2004 timeframe. The Progress schedule has decreased from 6 to 4, perhaps only 3. There have been 21 successful US and Russian missions since July 2000. Construction of the truss structure is continuing on schedule. The US and Russian teams are working well together. The prime contractor development is about 98% complete. Although there are no funds allocated to the US life support system, the Program will probably fund this out of reserves. In response to a question, Mr. Hedin indicated that the core complete can accommodate 27 US user racks; however, OBPR only has the budget for 20 (due to the cut in the research budget). Japan has been asked about accelerating the Centrifuge Accommodations Module (CAM) to early 2007 or 2008. Mr. Hedin showed the deployment planned for 2002 and 2003. On-orbit operations in 2003 will be very complex. The European and Japanese elements are scheduled for deployment in 2004 – 2006. "US core complete" occurs in February 2004 with deployment of Node 2. There is about a $600 million challenge in the budget. The Program has reserves at approximately this level. An independent cost assessment is on-going to validate the cost projections. Mr. Hedin showed the research infrastructure growth from 2001 through 2005.

IMCE Overview

Mr. Hedin briefed the Task Force on the results of the IMCE Task Force. He described the origin of the problem and the major factors in cost growth since Program redesign. The consequence was that the additional funding required for development was taken from research, and research plans were moved to the right. The total slippage for the PIs was about 4 ½ to 5 years. Dr. Shirley noted that this is a very serious issue. Other Task Force members amplified this comment. Careers are lost and the next generation of students is discouraged. Mr. Hedin added that integration time is another frustrating factor. This needs to be a priority activity. The most pressing concern now is Node 2, which enables the IPs. The rest of the US hardware appears to be on schedule. In response to a question, Mr. Hedin indicated that there is real risk to the 20 hour per week average for utilization. Without an increase in flight rate, the ability to expand the utilization crew time is very limited.

Mr. Hedin addressed the IMCE findings with respect to the program baseline and maximizing research. The report stated that lack of a defined program baseline was causing confusion and inefficiencies. The research hardware element of ISS was being implemented as the original program, e.g., a 7-person crew. Many were assuming a 3-person crew plan as temporary. The status of the centrifuge module ranged from top-priority to cancellation. The IMCE Task Force saw the need for a "roadmap" based on core complete with gates leading to an "end state." Science priorities will ultimately drive the requirements on station and the end state. The science plan that the IMCE Task

Force saw did not reflect the current budget situation or the unique research capabilities of the ISS. The ReMAP Task Force activity is the beginning of the requirements definition. By this fall, the Program needs to have an estimate on what it would cost to build to an end state consistent with those requirements. This would allow for a 2004 budget action that would enable the Program to build to the end-state. In response to a question, Mr. Hedin stated that "acceptable Program performance" pertains to the overall ISS program, both station and research elements. The near term performance "gates" are primarily cost and management, including an integrated research plan (a set of priorities) with adequate reserves. The ISS Program is being challenged to reduce operations cost. The issue relative to research management was the apparent lack of alignment with the President's budget. Also, it didn't appear that research had a real "place at the table." Ms. Kicza stated that OBPR now has the management responsibility for the research capability and is establishing the budget baseline. OBPR now has the commitment from the Administrator to put in place the program structure to accomplish this. There will be a resident research position at ISS, and that person will report to Ms. Kicza. The science agenda will drive the Program. The ISS Program Manager reports to NASA HQ. With respect to "science return," Ms. Kicza indicated that she would look to the ReMAP Task Force to give her guidance on the best metrics to use. She acknowledged that there will need to be some ISS Program process improvements to make the system more amenable to research. Mr. Hedin noted that the IMCE Task Force recommended giving highest priority to research directed at solving problems associated with long-duration human space flight, including engineering required to support humans in long-duration space flight. Dr. Bula noted that this ignores a lot of the history associated with the support of the ISS. Dr. Silver emphasized that the ReMAP Task Force has been chartered to determine what the priorities should be. The IMCE Task Force felt that the centrifuge was mandatory to accomplish top priority fundamental biology research. In response to a question, Mr. Hedin indicated that the centrifuge is being responsibly developed. It is being driven by technical issues, but NASA has confidence that it will be deployed on schedule. The question is whether delivery can be accelerated to 2006. Dr. Silver indicated that this could be part of the ReMAP Task Force recommendations.

ISS Research Accommodations and Resources

Mr. Mark Uhran discussed the original operations objectives during the ISS assembly phase and ISS post-assembly phase and described the US core complete. He emphasized that this is an extraordinarily large spacecraft with many payload accommodation elements. Mr Uhran showed the international allocations in the Memoranda of Understanding (MOUs); these will not likely change. The US has most of the resources. He also showed the payload accommodations at assembly complete, both internal and external. About 50% of the utilization sites are outside of the laboratories. Currently, the US has one payload planned for the Japanese Exposed Facility. Mr. Uhran discussed the capabilities at the internal and external sites. Although there are International Standard Payload Rack sites in the European and Japanese labs, there is no rack interchangaability with the Russian facility. The MOUs require a certain organizational structure across the partnership to manage the program. The US Space Station Utilization Board is the executive authority for all strategic policies and plans associated with utilization by US entities. Mr. Uhran showed the current NASA ISS utilization allocations, which were

agreed to by all of the Associate Admininstrators for NASA's research offices. The research challenge is to integrate over a dozen diverse research disciplines from 16 nations and conduct research throughout a dynamic construction phase. The job of the international working groups is to seek collaboration to eliminate redundancies. The fundamental constraint is the number of sites available. In addition to this static constraint, there are dynamic constraints: telemetry, energy, logistics, and crew time. Each of the research topical areas has different constraints, and any one of the station constraints may be the limiting factor for each of these areas. Based on the station resource capability, about 20% to 40% of the payloads could be operated simultaneously at assembly complete. During the period of extreme crew constraints, the Program has pragmatically selected research areas that can be accommodated within this constraint. Mr. O'Keefe wants the ReMAP to be unconstrained and look at what the research priorities should be. Dr. Silver indicated that the ReMAP terms of reference require the Task Force to address what the research priorities should be for core complete, and that the Task Force needs to understand the crew hours available for research. Ms. Kicza stated that what is critical to consider is the following: What are the research priorities? What platform is most suitable? Given the priorities and the most suitable platform, what research is best suited to ISS? The Station then needs to work on how to address those priorities. The ReMAP should stick to what the research priorities should be. Mr. Uhran continued with his presentation and showed the complexity of the actual manifesting process, the scope of the laboratory facility, and the scope of the external facilities. After one year of operation, the first racks are on-orbit and there will be 5 on-orbit by early next year.

Research Prioritization Criteria and Prioritization Process – Part I

Dr. Clinton described the prioritization process in OBPR and presented a strawman draft of prioritization criteria. The processes for establishing priorities within the disciplines are fairly well established. With respect to cross-discipline prioritization, the OBPR prioritization team relied most heavily on the SSB studies, which focused on space station research and was concerned about prioritization across disciplines. OBPR must re-prioritize within the set of new constraints (reduced funding and other resource limitations). OBPR has developed a draft set of criteria and a two-step process for prioritization of research across disciplines. The first step involves the assessment of research merit (the ReMAP primary focus area). The second step (implementation) is NASA's responsibility. Dr. Clinton reviewed the heritage of the OBPR proposed criteria (relevant sources and guidelines). OMB has three criteria: quality of research; relevance to the funding agency; and performance (based on defined goals and measures). OBPR ensures quality of research through the peer review process and reviews throughout development. NASA relevance is a key criteria in the evaluation process. The ReMAP involvement is limited to these two criteria. NASA will address performance goals and measures. The NRC stated that it is impossible to rank the disciplines of science or space research in a priority order. It is essential to concentrate on the initiatives (research focus areas or research themes) produced by the disciplines, not the disciplines themselves. The SSB recommended four criteria for prioritizing research: scientific merit, contribution to national goals, cost, and likelihood of success. The OBPR recommended criteria are consistent with the OMB and NRC guidelines. The governing principle is

"science drives the mission." OBPR proposes that the ReMAP Task Force consider the following criteria for "research merit:" impact to broad scientific and technological community; scientific importance; contribution to national goals; and vital to NASA's mission. NASA proposes that the Task Force consider the following criteria for "implementation:" ISS resource impact; technical feasibility; and overall risk assessment.

Dr. Clinton provided a representative sample of key questions to frame the discussion for each of the criteria. In response to a question regarding the key science questions from each Division, Dr. Ostrach noted that the Task Force will be working with the Division Directors to address these questions. In response to a question, Dr. Clinton noted that one of the criteria that was eliminated was "benefits to society." The NRC felt that scientists did not have the background to evaluate this criterion. Dr. Osborn suggested that the question regarding a NASA-unique facility or expertise be added to the "vital to NASA's mission" criterion. Generating the next generation of scientists for ISS research should be included in some manner under "contributions to national goals." In response to a question regarding the process for applying the implementation criteria, Dr. Clinton indicated that the implementation criteria could be used to rank-order research as high, medium, or low. Dr. Ostrach explained the scoring process that has been used in evaluating proposals for technical feasibility. Dr. Osborn offered another question for consideration: Does the research require long-term facilities (ISS), or can it be carried out on a shorter-term platform? With respect to research merit, are there disciplines or sub-disciplines that are particularly important for some reason? Beyond that, the Task Force should look at the major scientific issues and what experimental approaches are most appropriate. These all should go into the scientific merit criterion.

Dr. Clinton asked the Task Force to review and modify the draft that he provided, and present its recommended criteria for research merit assessment and implementation assessment. ReMAP was then requested to focus attention on the first of the two steps, research merit. NASA OBPR will perform the implementation assessment. In response to a question, Dr. Clinton indicated that OBPR is proposing this formal process for prioritizing across disciplines. Dr. Lee used the "atomic clock" experiment as an example to demonstrate application of the research merit and implementation criteria. This could be done with each initiative. Another issue that was discussed was "relevance to NASA's mission." OBPR contributes to NASA's mission in three areas, as noted by Dr. Trinh in his presentation the previous day. Although Dr. Lee used the atomic clock as an example to walk through the criteria, Dr. Ostrach emphasized that in order to prioritize the research (the ReMAP's charter), the criteria should be applied to research areas (the themes), not individual experiments.

<u>Summary Executive Session</u>

Ms. Kicza joined the ReMAP for its executive session. Dr. Shirley indicated that the Task Force needs help with the prioritization. The Task Force has not gotten input from the program offices on the early indications of the priority of the research projects. The Task Force is not a peer review group; it is more of a study panel and it needs the following: input from each of the program offices within OBPR as to the relative merit of their best proposals. He emphasized that the Task Force is not looking for something

to cut. However, it is important to do the things that really need to be done. After receiving this input, the Task Force can discuss what it feels are the priorities among initiatives. Dr. Turek indicated that he would like to see the Task Force go beyond the current projects and get input from the offices on what they feel is important research that is not currently part of the funded program. The Task Force would like to get the most useful information from the program offices. Ms. Kicza indicated that it would be reasonable to ask the program offices to take the recommended criteria and go back and do a "first cut" ranking within each Division, as well as identify which platform each research area can be accommodated on and the unique need for ISS. In that respect, the questions should be: What are the unique attributes of ISS? Which experiments can ONLY be done in that environment? Dr. Shirley asked if the program office input could be provided to the Task Force before the next meeting. Ms. Kicza indicated that if the output of this meeting was a recommended set of criteria that the directors could work with, then the Task Force could be given a response before the next meeting.

The Task Force agreed that the outcome from this meeting should be a set of criteria. Using that, what the directors should come back with is an answer to the following questions: What are the most critical scientific questions? What is the most critical scientific research that needs to be done?

The other task for the Task Force is to go through the previous prioritization reports and work with the OBPR staff to distill the relevant recommendations from those reports. Dr. Silver indicated that this meta-analysis should be included in the Task Force report. With respect to the IPs, Dr. Silver indicated that a subgroup will meet with the IPs. They have indicated that they want to share how their research priorities may impact on what OBPR wants to do. The subgroup will report back to the Task Force. The Administrator has advised that the Task Force should not allow politics to enter into its deliberations.

Recap of actions:
Dr. Silver asked for volunteers to work with the NASA staff on the report digest and "Meta-Analysis" before the next meeting. Drs. Osborn, Acrivos, Viskanta, Beachy, and Bula volunteered for this task. The digest will be discussed at the next meeting.

Assignments:
Physical Sciences: Acrivos, Viskanta
Life Sciences (fundamental space biology and bioastronautics): Osborn, Bula, Beachy
Space Product Development: Bula (literature to be identified)

Actions and schedule:
I. Report Meta-Analysis
Code U: Identify staff that will work with TF members: 4/4
Code U: Confirm the list of reports that need to be addressed (including product development: 4/9)
TF Feedback to staff: 4/9
Code U: Digest of reports: 4/15
TF Feedback to staff: 4/19

Code U to provide copies to all TF members

II. Work with Division Directors on questions (**see below)
- Liskowski,– Turek, Pawelczyk
- Trinh – Morris, Oran
- Uhran - Bula
- Fogleman – Pohland, Pawelczyk, Seddon

[Task Force to choose modes of communication – if questions and issues arise, direct to Lee]

**
What are the six most important questions? (repeat the question to fewer #)
What is the rationale?
What is the most important research on the ground?
What is the most important research on ISS core complete?
What is the most important research on ISS beyond core complete?
What is the best on-going research?
Where do you want this program to be in 10 years?
What do you need to do that is essential?

III. Sanity check on questions and priorities
With the recommended prioritization criteria and the answers to these questions (white paper), each Division Director establish and present the relative priority (ranking) of the research areas. Identify where ISS is unique.

Schedule:
White paper: 4/10
Relative ranking: 4/15
4/15 to 4/23 - review by all TF members
4/23: presentation by Division Directors; individual TF members report as necessary
4/23-24 (next meeting): integration of research priorities

IV. International Partners Subcommittee
Pawelczyk, Silver, Whitesides, Oran
Meeting location: New York
Purpose of meeting: Is there anything about your research strategy that we should know? What are your top priorities? Work with NASA's International Liaison office.

Research Prioritization Criteria and Prioritization Process – Part II
The TF recommended that the criteria under research merit assessment should be rank ordered as follows:
1) Scientific importance (add to the set of questions: Is this research going to help develop the future generation of scientists?)
2) Impact on scientific and technological community
3) Relevant to NASA's mission
4) Contributions to national goals

Implementation Assessment

1) ISS resource impact
2) Technical feasibility
3) Overall risk assessment

Dr. Shirley adjourned the meeting at 2:45 p.m.

MEETING ATTENDEES

Task Force Members:

Silver, Rae (Chair)	Columbia University
Shirley, David (Vice Chair)	University of California, Berkeley
Acrivos, Andreas	City University of New York
Beachy, Roger	Danforth Plant Science
Bula, Raymond	University of Wisconsin, Madison
Lee, Mark (Executive Secretary)	NASA Headquarters
Metcalf, Harold	State University of New York, Stony Brook
Morris, Patricia	DuPont Company
Oran, Elaine	Naval Research Laboratory
Osborn, Mary Jane	University of Connecticut
Pawelczyk, James	Penn State University
Pohland, Frederick	University of Pittsburgh
Seddon, Rhea	Vanderbilt Medical Group
Stein, Gary	University of Massachusetts
Turek, Fred	Northwestern University
Viskanta, Raymond	Purdue University
Whitesides, George	Harvard University
Wiltzius, Pierre	University of Illinois
Zoloth, Laurie	San Francisco State University

NASA Attendees:

Ahlf, Peter	NASA Headquarters
Bartoe, John	NASA/JSC
Brown, Dwayne	NASA Headquarters
Carpenter, Brad	NASA Headquarters
Chambers, Larry	NASA Headquarters
Chandle, Scott	NASA Headquarters
Chiaramonte, Francis	NASA Headquarters
Clark, Kathryn	NASA Headquarters
Clinton, Corky	NASA Headquarters
Davison, Steve	NASA Headquarters
Emond, John	NASA Headquarters
Erickson, Kristen	NASA Headquarters
Flaherty, Chris	NASA Headquarters
Gitliss, Donald	NASA/MSFC
Guerra, Lisa	NASA Headquarters
Israelson, Ulf	NASA/JPL
Jarvi, Jullin	NASA Headquarters
Kerwin, M.D.	NASA Headquarters
Kicza, Mary	NASA Headquarters

King, Merrill	NASA Headquarters
Larson, David	NASA Headquarters
Lucid, Shannon	NASA Headquarters
Olsen, Kathie	OSTP/NASA Headquarters
Ostrach, Louis	NASA Headquarters
Pline, Alex	NASA Headquarters
Rafferty, L.	NASA Headquarters
Shortz, Donna	NASA Headquarters
Trinh, Gene	NASA Headquarters
Uhran, Mark	NASA Headquarters
Wargo, Michael	NASA Headquarters

Other Attendees:

Connors, Corey	Smith Bucklin/NASDA
Dubinin, Andrey	Russian Embassy
Kosaka, Akira	NASDA
Krutikov, Sergey	Russian Embassy
Pryke, Ian	ESA
Vodyrnoy, Igor	ONR

LIST OF PRESENTATION MATERIAL

1) Ethics Briefing for Members of the Biological and Physical Research Maximization and Prioritization (ReMAP) Task Force [Rafferty]
2) ReMAP Charter [Kicza]
3) Ground-based and Flight Research and Development Overview of Current Programs and Plans [Trinh]
4) Bioastronautics Research Division [Fogleman]
5) Fundamental Space Biology – Program Overview [Liskowsky]
6) Fundamental Space Biology – Issues and Results of ISS Restructuring of the Space Station Biological Research Project [Liskowsky]
7) Physical Sciences Program – Earth-based and ISS Research Program [Trinh]
8) Commercial Space Research [Uhran]
9) ISS Management and Cost Evaluation Task Force (IMCE)
10) ISS Research Accommodations and Resources [Uhran]
11) Prioritization Criteria and Process Development for OBPR ReMAP Task Force [Clinton]

Materials distributed at the meeting:

1) Report by the International Space Station (ISS) Management and Cost Evaluation (IMCE) Task Force
2) NASA Space Commercialization – Space Product Development (annual report)
3) National Science Board – Federal Research Resources: A Process for Setting Priorities
4) Space Research, Office of Biological and Physical Research, March 2002
5) Plant Biology in Space
6) Medicine & Science in Sports & Exercise, October 1996
7) International Journal of Sports Medicine, Muscle Research in Space, International Workshop October 13-16, 1996
8) Review, Developmental Biology Research in Space: Issues and Directions in the Era of the International Space Station, September 1999
9) Brain Research Reviews, November 1998
10) Aviation, Space, and Environmental Medicine, International Workshop on Human Factors in Space, July 7-8, 1999
11) Bone, International Workshop on Bone Research in Space, November 11-13, 1996
12) Fundamental and Molecular Mechanisms of Mutagenesis, November 1997
13) Readiness Issues Related to Research in the Biological and Physical Sciences on the International Space Station, Space Studies Board
14) NASA Office of Biological and Physical Research (OBPR) Research Maximization and Prioritization Task Force Terms of Reference

Meeting #2 Agenda and Minutes

April 22-24, 2002

Monday , April 22, 2002

Location: NASA Headquarters
300E St. SW
Washington, DC 20546
Room: 7H46 (MIC 7)

7:00 PM	Pre ReMAP Meeting Get Together Dinner at The Washington Plaza Hotel at 10 Thomas Circle, NW Washington, DC 20005 202-842-1300

Tuesday, April 23, 2002

Location: NASA Headquarters
300 E St. SW
Washington, DC 20546
Room: 7H46 (MIC 7)

8:00-8:10	Review of Agenda	Silver/Shirley Ostrach
8:10-8:40	NASA Vision	Kicza
8:40-9:00	Presentation by Chair	Silver
	Biomedical Research and Countermeasures	
9:00-9:30	Prioritization & Justification	Fogleman
9:30-10:00	Meta-analysis Comparison	Osborn
10:00-10:45	Deliberation	Panel only
	Fundamental Space Biology	
10:45-11:15	Prioritization & Justification	Liskowsky
11:15-11:45	Meta-analysis Comparison	Pawelczyk

11:45-12:30	Deliberation	Panel only
12:30-1:30	Working Lunch	
	Biotechnology Applications	
1:30-2:00	Prioritization & Justification	Trinh
2:00-2:30	Meta-analysis Comparison	Stein
2:30-3:15	Deliberation	Panel only
	NASA Vision	
	Advanced Human Space Technology	
3:15-3:45	Prioritization & Justification	Fogleman
3:45-4:15	Meta-analysis Comparison	Pohland
4:15-5:00	Deliberation	Panel only
5:00-5:35	NASA Van to Air & Space Museum	
5:35-6:15	3D IMAX ISS Movie	
6:15	Adjourn NASA Van Back to NASA HQs for Those Who Need It	

Minutes: Tuesday, April 23, 2002

Dr. Rae Silver, Chair of the ReMAP Task Force, called the meeting to order. After introductions, Dr. Louis Ostrach, Executive Secretary, made logistics announcements and reviewed the agenda.

NASA Vision

Ms. Mary Kicza briefed the Task Force on the "NASA Vision"—to improve life here, to extend life to there, and to find life beyond. Three specific mission elements support the vision: to understand and protect our home planet, to explore the universe and search for life, to inspire the next generation of explorers, as only NASA can. Ms. Kicza described how this vision will change NASA. Decisions will be science driven, not destination driven. Education is now part of NASA's core mission and will become an integral part of all programs. NASA will be focused on those activities that are unique to the Agency's mission in air and space. Activities will be integrated across the Agency and programmatic and budget decisions will be aligned with the mission statement. At this point, the individual Enterprises are looking at how they align with the vision, recognizing that technology investments are to be made with the vision in mind.

Presentation by Chair

Dr. Silver reviewed the Task Force terms of reference (included in the material from the first meeting), the information that is available to the group, the expertise on the Task Force, and the process that will be used to achieve the task. The Divisions are represented in eight realms of research: microgravity, engineering, biotechnology, fundamental space biology, commercial engineering, commercial applied, biomedical research, and advance space technology. Dr. Silver showed the FY02 budget allocation among these areas, and the Division Directors' prioritization within each. The Task Force will review and prioritize these realms of research. Dr. Jones requested the FY03 budget numbers. In response to a request, Ms. Erickson noted that the FY03 numbers are within 5% of the FY02 numbers. The Task Force has been divided into the categories that the Division Directors have used. The Task Force will provide expertise to those areas. The Task Force also has the expertise from the staff in the Office of Biological and Physical Research (OBPR), including Ms. Kicza, Ms. Lisa Guerra, Dr. Ostrach, and Mrs. Ann Carlson. The Task Force has the following information available to it: the information from the Division Directors and the rationalization of their priorities; previous reports by the Space Studies Board (SSB), the National Research Council (NRC), etc.; and Task Force expertise. Dr. Silver briefly reviewed the background of the Task Force members. This Task Force will not make decisions on International Partner and national (US) goals; the Task Force's job is to inform the decision-makers what can be done, given the resource available. However, what the Task Force says can impact back on the goals. Ms. Kicza added that the Task Force will look at the OBPR portfolio and give the organization a sense on how the national agenda can best be served. This will inform NASA on which area it should emphasize to achieve the maximum research return. Each of the Division Directors discussed his rationale for prioritization. The Task Force then held a closed deliberation on each.

Biomedical Research and Countermeasures

Dr. Guy Fogleman reviewed the OBPR prioritization and rationale for biomedical research and countermeasures. Biomedical research and countermeasures is directed to the human response to the space environment. The program can be divided into six areas. Priorities were developed by using the prioritization criteria developed by the Task Force (a science-based approach). The highest priority area is radiation health. The next is integrated physiology (nutrition, immunology). A risk in this area is bone loss. The next area is organ system physiology. A particularly critical area is looking at the risks that relate to the heart. The fourth area is clinical and operational medicine, and includes technologies for wound healing and medical treatment. There are a number of critical risks in this category. The fifth area is behavior and performance. Critical risks include communication between the flight and ground crew that cause performance problems. The six area is environment health, including understanding the prebreathe protocols.

Within the Division, radiation was rated highest using the definitions and rules contained in the prioritization criteria. Dr. Osborn noted that impact on the scientific community is an important criteria, but in this research realm, the impact on the scientific community at large should be less important than it would be in other realms. The reason that

biomedical research and countermeasures exist is the health and safety of the crew. The radiation community is small, and there usually is a small proposal response. One of NASA's tasks is to bring this community along with it. This program is need-driven, rather than driven by the desire of the community. Dr. Stein commented that even if there were no spin-off from NASA, every one of the research areas is necessary and must be addressed. Dr. Fogleman noted that relevance to NASA's mission was not a major discriminator in the ranking process. Behavior and performance is a major issue although it did not come out high in the ranking process when using the prioritization criteria. Prior to this exercise, the priorities in the program have been based on risk (astronauts' health) and evidence-based medicine. Dr. Fogleman distributed a draft paper on the prioritized risks for a balanced program. The science prioritization resulted in a dramatically different ranking. In response to a question, Dr. Fogleman noted that it is difficult to rank the "research areas" using the risk-based approach. There is a cluster of seven high priority questions that must be answered; these cut across the defined research areas. The Task Force felt that these research realms reflect occupational health and safety, and is different from the other research realms. Dr. Fogleman reviewed the reasons for using the ISS (contained in the Bioastronautics Research white paper).

Dr. Osborn reviewed the meta-analysis. It was based on the core strategy report on research in space biology and medicine, a 2000 review of the biomedical research program, and a recent Institute of Medicine (IOM) report that focused on what kind of medicine and supporting research needs to be done for long-duration space flight beyond low Earth orbit (LEO). The core recommendations come from the strategy report. The criteria for the priorities were research aimed at understanding and ameliorating problems that may limit astronaut's activity during prolonged space flight. Based on this, there was a limited list of "show stoppers" for long-duration flight. One of the best-documented problems is loss of weight-bearing bone and muscle. The vestibular system is another system that we know responds to gravitational force. Orthostatic intolerance is another major and potentially catastrophic problem. Most of the radiation studies have been ground-based. This area has not received adequate attention in the past. Flight studies would test hypotheses and validate countermeasures developed on the ground. ISS would be the only reasonable platform for these studies. Psychological and social issues have consistently been neglected. Experiences on Mir have demonstrated that these problems can be major and dangerous. Ground-based analogs are the major source of information. Currently, ground-based research constitutes the program. Hypotheses must be tested in space. Dr. Osborn emphasized that there is more than one problem that could be a potential "show stopper," e.g., radiation, loss of bone and muscle, orthostatic intolerance, and psychological and social factors. In response to a question, she indicated that for long-duration flight, medical care issues would be increasingly important. In response to questions by the Task Force, Dr. Silver requested some data on cardiac arrhythmia. Dr. Osborn stated that she could not give a singular top priority; several aspects would be in the "top box." Separating integrated physiology from organ physiology is somewhat arbitrary.

Closed Session

The Task Force held a closed session meeting at this time.

Fundamental Space Biology

When the meeting resumed, Dr. Liskowsky reviewed the OBPR prioritization and rationale for fundamental space biology. The prioritization was done using the criteria that was established by the Task Force. The Division also looked internally at how well the elements support the six broad research questions that were provided to the Task Force. The highest priority area is cell and molecular biology. This serves as the foundation for all of the subsequent research and underlies everything that is done. It has a high science impact. Understanding the physiological responses in systems associated with spaceflight and the basic mechanistic studies form a foundation for the research. The second priority area (inextricably intertwined with the first) is organismal/comparative biology. These two areas are the foundations that support the biomedical area. Given the linkage of this research to physiological issues, there is a relevance that can be applied to medical conditions on Earth. What is unique to NASA is studying how gravity is sensed at the molecular level in a microgravity environment. The key question is how gravity is transduced. Dr. Osborn commented that it would be useful to know what the National Institutes of Health (NIH) is doing with respect to mechanical transduction, in order to look at what NASA can do that nobody else is doing or can do. What is unique about NASA's role is that it applies that research in understanding gravity as a physical force, i.e., it examines microgravity as a variable. Ground-based research is used to test initial hypotheses. It is important to have the parallel studies. The developmental biology that NASA does is specifically related to the development of systems that respond to gravity. Some of the developmental biology questions can only be answered in microgravity. What must be determined is the direct effect of microgravity on systems as opposed to secondary effects of the space environment. In the absence of a centrifuge control, it is impossible to determine what is direct from what is indirect effect. Dr. Whitesides requested more information on the cell biology studies. Currently, three flight experiments have been selected for ISS. Fundamental space biology is the last organization to use the platform. Ultimately, there will be 50 or 60 investigations per year. Dr. Turek requested a "one-pager" on the effect on the cell cycle and what will be tested on the International Space Station (ISS) to answer a key question. How will the studies in the pipeline address the fundamental questions? Since 1998, the Division has been looking at the future of the program, particularly with regard to ISS. What capabilities will ISS provide that will allow studies that have not been possible in the past? ISS will provide long-duration exposure to the space environment. How organisms respond to the space environment is one of the key questions. This leads to questions about permanent adaptation to space and the elements of developmental and evolutionary biology. Programmatically, it provides a point of intersection with the astrobiology community in space science.

Dr. Pawelczyk reviewed the meta-analysis. The two key reports are the same that were highlighted by Dr. Osborn. Dr. Pawelczyk abstracted the recommendations from these reports. He observed that there are ways that the fundamental biology program is evolving that is different than set out in the reports. The goals are very well-stated in the

reports—to understand the role the gravity plays, to determine if any biological phenomena are better studied in space than on Earth, and to use that to improve the health and safety of astronauts. Functional changes (and how those are biologically or medical significant) is a key issue. The Task Force subgroup abstracted the salient points of the reports. In cell biology, the key question is whether gravitational forces acting directly on single cells can be amplified to a physiologically significant signal. This remains an open but focused question. The thing that comes first is excellent habitats and facilities. With respect to developmental biology, there are very few opportunities for flight. The approach that the report suggests is to use as a test the idea of an "end point," e.g., generate at least two cycles of an organism in microgravity. When things fail or there is a problem, go after the mechanisms as a scientific priority. Plants are uniquely represented in the reports. A large number of models have been used and have been tested in a variety of ways. The better approach would be to isolate on a few model systems and marshal resources. Gravity must be analyzed alone, and excellent facilities are needed to control other environmental conditions. The key recurring themes from the report are: hardware development (the need for superior apparatus); cycles of life (focus on higher order species because that is where the critical information is missing); biological or medical significance; complex cell systems (avoid the single cell line idea); and higher order animals. Dr. Pawelczyk showed the number of references from the meta-analysis for each research element. Dr. Liskowsky noted that the new areas (evolutionary biology and gravitational ecology) are driven by the capabilities of ISS and were not reflected in the 1998 NRC report.

Closed Session

The Task Force held a closed session meeting at this time.

Biotechnology and Applications

Dr. Eugene Trinh reviewed the OBPR prioritization and rationale for biotechnology and other Earth-based applications. The highest priority is cell science and tissue engineering. The first component is to understand the basic relationship of cells in space. Tissue engineering is the application of that research. Tissue engineering, using the bioreactor, has been successful in the private sector. Because of the consequences of the scientific impact, this area merits a very high rating. Microgravity results in the capability to assemble tissues in three dimensions. This area also has high potential for benefit to technology on Earth. The second priority is structural biology. It has a strong scientific basis and there is also a high potential for impact on biomedicine. The Division has re-oriented the program and has established an educational component geared toward middle and high schools to allow them to get directly involved in the preparation of samples for spaceflight. The next highest priority is energy conversion, which includes combustion research. Miniaturization of the capability is one area of importance. Knowledge of the fluids area is used to develop the technology. Even though applications is a "catch-all" category, the prioritization makes sense using the science criteria. The ranking of the program is in execution; the program is learning and the maturity of components relates to the probability of success. Because of the maturity of the top priority areas, the potential for impact is greater. Material synthesis and processing has not benefited from extensive spaceflight experience.

Drs. Stein and Jones reviewed the meta-analysis. Dr. Stein presented a summary of the NRC report on the biotechnology program. The Committee assessed the optimal utilization of the ISS in terms of supporting crystallography and cell science. It examined the scientific goals of the program, the instrumentation available, and the interactions between NASA and the scientific community. Dr. Jones discussed the crystallography aspects of the program. The NRC group addressed the issue with respect to the value of the program. The results produced to date by the protein crystal growth program are inconclusive. From an examination of the work that has been done, there does seem to be an intriguing effect and some improvements in resolution. However, it is hard to definitively credit the microgravity environment for these improvements. The impact of microgravity crystals on the field of structural biology has been extremely limited. The question with respect to cell science was the potential impact of the cell science studies. There were concerns with the issue of the appropriate types of experimental controls. With the transition from Shuttle missions to Space Station-based research, this can in part be rectified. The general recommendation was closer integration among the activities being supported by NASA. There was also a recommendation for increased collaboration among agencies. Instrumentation was an issue that was cited. Additional instrumentation should be placed on the ISS when funds are available. The ISS should allow experiments that are more analogous to ground-based studies. There was recognition of a limited amount of crew time and infrequent access to samples. This limits the type of experiments that can be carried out.

Dr. Osborn posed the question: What is the difference between biotechnology and fundamental cellular biology? Biotechnology has to deal with hardware and developing the systems. When it comes to biological experiments where the overlap between the two programs is very large, where are the questions addressed in the most sophisticated way? Dr. Silver noted that the reports did not really address the priorities for this realm of research. Dr. Pawelczyk observed that the reports emphasize the importance of in situ.

Closed session

The Task Force held a closed session meeting at this time.

Advanced Human Support Technology

Dr. Fogleman reviewed the OBPR prioritization and rationale for advanced human support technology. The Division is going after risk and making the Station and crew more effective. This program is the other side of the bioastronautics research program. It looks primarily at the environment of the human and focuses on the interaction between the human and the environment. This program has a strong technology research component. The research task is to understand the support system and make it as efficient as possible. As with the biomedical research program, prioritization was done based on the science criteria. Dr. Fogleman focused on the risk and effectiveness aspects. The highest-ranking element was advanced environmental monitoring and control. The idea is to develop technologies for a suite of small, lightweight sensors for air, water, and surfaces. NASA and DARPA have common interests in this area and are leveraging off of each other's research. The next priority area is human factors engineering. This is

traditional ergonomics as well as human/machine interaction, scheduling of events, training protocols, and team performance. The Division is focusing the research on issues associated with longer-duration missions (Space Station). The third priority is advanced life support (cabin air and water, trace contaminant control, etc.). The pay-off here is lower maintenance or lower logistics. This is also where a lot of the integrated systems work is done, e.g., a bioregenerative system for a small number of people. Dr. Shirley noted that the number of crew hours that could be saved would be a good figure of merit. He requested a rough-order-of-magnitude estimate on this and further detail on the up-mass savings (by increment) by the next meeting. The final area is advanced Extravehicular Activity (EVA). The current EVA systems require a lot of maintenance. The Division is working on marginal improvements that could increase dexterity and the amount of time that the crew could stay on EVA. The Division works with the people developing the crew systems to understand where the issues are; it then brings the technology up to around Technology Readiness Level (TRL)-6 and does the translation with the program.

Dr. Pohland reviewed the meta-analysis. There are four reports that are germane to this topic. The principal one was the 1997 NRC report on advanced technology for human support in space. The report was not only a review of the research, but also a review of the programmatic aspects. Dr. Pohland focused on the review of the research. He provided the evaluation criteria that applied to the principal document. Advanced EVA was very low on the meta-analysis. Recommendations were made and the status of what has happened since was described in the meta-analysis. Dr. Pohland highlighted the principal issue in each recommendation. The issue of system analysis was something that was lacking at that time, but the Division is in a much better position now. Most of the water systems and air systems can be automated. One of the big "show stoppers" (and the most challenging) is the waste management system. Most of these systems are still in partial closure. There were some recommendations with respect to advanced EVA; however, it will take an entirely new system to realize substantial progress. Any perturbation in the system needs to be planned for and sensed properly. Dr. Pohland showed a list of the most critical research questions for advanced human support technology.

Closed session

The Task Force held a closed session meeting at this time.

Commercial Applied Sciences

Mr. Mark Uhran reviewed the OBPR prioritization and rationale for commercial applied sciences. The commercial program has had a prioritization process since its inception. Part of the vision is a breakthrough in microgravity processing. There are two different aspects of the diversity of the research that need attention—the diversity in the types of research and the diversity in the approach to conducting research. There is a valid role for cost shared research with industry. This is NASA's current best attempt to do cost leveraging. A clear set of investment criteria have been developed: the maturity of the product; time to market; funding ratio; initial market potential; total private investment;

and required flight activity. Each of the six criteria is weighted differently. Most of the systems pursuing research today are transmitting information.

The macromolecular crystallography program (biotechnology) is the highest priority. Resources have been concentrated to demonstrate the economical pay-off. Mr. Uhran provided some of the specific data to support the premise. For all samples flown, there has been a 20% success rate in obtaining higher quality samples grown in microgravity. Success rates increase with multiple flights (35% for samples flown more than once). Dr. Roberts requested a list of all of the crystals that have been crystallized in space that have not been crystallized on the ground. Mr. Uhran agreed to provide this data. On the basis of the empirical data obtained to date, the duration of the growth process is a significant factor in achieving a positive result. We are just beginning to get the first opportunities for 30-day growth period. This is why this program is the highest priority. Industrial monitoring and interest (a gate keeping function) has been higher on this program than any other. When competitive advantage becomes clear, industry will be ready to enter the market in a more significant way. The exit strategy is to pull all subsidies away and have industry assume all costs of going to space ($20 million for the size of a rack). The lower priority areas (agribusiness and advanced materials) do not have as much flight experience. Anecdotal results (what is available) lead people to believe that there is value in pursuing the research. Antibiotic production rates are much greater on orbit.

Dr. Bula reviewed the meta-analysis. He began by reviewing some of the history on the commercial use of space. In 1984, Congress made the first amendment to the Space Act. In 1988, Congress reiterated that the commercial use of space be included in the research activities. There have been a number of reviews pertaining to the activities of the Centers. All of the reviews conducted by NAPA or other organizations have rarely pointed out any deficiency in the research or technical aspects of the Centers. Any deficiencies were usually associated with the financial or business aspects. This is an industry-driven program—industry decides what experiments it will support. Dr. Roberts observed that the real issue is the industry funds that are at stake. When investment is small, industry "approval" does not provide any indication of whether or not the program is valuable. The area of research in the Centers is defined by industry; consequently, the reviews have told NASA that they have been satisfied. Dr. Silver noted that the job of the Task Force is to make a statement on the best possible work that can be done there. How can the work in commercial applied sciences realm be prioritized with the other science? Agribusiness research is looking at how to use the space environment to improve agricultural processes (e.g., more efficient genetic engineering). Another area of research concerns the chemical composition of plant materials—lignin formation and cellulose formation (of interest to the paper industry).

Dr. Jones discussed a demonstration system for protein crystallization. He noted that protein crystallization falls into two categories; the second has to do with the Commercial Space Centers (CSCs). This is where the equipment for growing crystals has been developed. A system for automating a great deal of the process has been developed at the Center at Birmingham, Alabama. Some aspects of the system are now on the market.

Advanced materials is a third priority because for the most part, the feasibility of making the materials did not meet the market requirement. The one part of advanced materials that has continued is the measurement of physical properties of complex alloys. This precision information can only be obtained in a containerless microgravity environment.

Closed session

The Task Force held a closed session meeting at this time.

Wednesday, April 24, 2002
Location: NASA Headquarters
300E St. SW
Washington, DC 20546
Room: 7H46 (MIC 7)

	Fundamental Microgravity Research	
8:00-8:30	Prioritization & Justification	Trinh
8:30-9:00	Meta-analysis Comparison	Voorhees/ Viskanta
9:00-9:45	Deliberation	Panel only
9:45-10:00	Break	
	Engineering Research Enabling Exploration	
10:00-10:30	Prioritization & Justification	Trinh
10:30-11:00	Meta-analysis Comparison	Acrivos/ Viskanta
11:00-11:45	Deliberation	Panel only
11:45-12:45	Working Lunch	
	Commercial Engineering Research	
12:45-1:15	Prioritization & Justification	Uhran
1:15-1:45	Meta-analysis Comparison	Bula
1:45-2:30	Deliberation	Panel only
2:30-TBD	Deliberation	Panel only
TBD	Adjourn	

Minutes: Wednesday, April 24

Fundamental Microgravity Research
Dr. Trinh reviewed the OBPR prioritization and rationale for fundamental microgravity research. Two things are necessary for a good research program: a dedicated, skillful

research community, and a dedicated capability. The Division can carry out the type of research described at this meeting. The Division has used reports and studies from various NRC and NAS committees. The NRC has also looked at physics and astronomy, including "physics in a new era." This report is useful as a reality check. Out of the six major physics thrusts cited in the report, the Division has five of them. Dr. Shirley asked for a brief description of the most compelling physical research for ISS. Dr. Trinh stated that he would get most excited about new tools that lead a new level of understanding of complexity at the molecular and cellular level, e.g., Magnetic Resonance Imaging (MRI), tools to manipulate DNA, etc. The analysis is potentially able to attack some major problems—to look at the physical/chemical systems at the foundation of the response to gravity. One of the goals of the NASA programs should be to understand the root causes and mechanisms. One example of such research is colloidal physics—understanding the mechanics of phase transformation. This area of research was ranked at the highest priority. The ratio of ground to flight research is five to one. Dr. Kicza asked Dr. Trinh to give a key example of highly rated research in each area that was ranked by the Division: phase transformation (colloidal physics); condensed matter (Bose-Einstein condensate); fundamental laws (verification of contemporary theories, e.g., the Lambda point experiment); kinetics, structure, and transport (measurements of phenomena in condensed matter physics, e.g., thermal capillary flow); fluid stability, dynamics (an overriding theme in low-gravity research, e.g., development of technology for life support and spacecraft); and thermo-physical, physio-chemical (a new measurement system, e.g., containerless positioning).

Dr. Peter Voorhees, Chair of the Committee for Microgravity Research at the NRC, discussed a NRC study that is addressing many of the issues of interest to the Task Force. The Committee has not yet released its report, and Dr. Voorhees stated that he could not state any findings or recommendations relative to priorities or additional areas of opportunity. NRC policy requires external review of a completed report before any findings and recommendations can be released. However, he did share information and statistics (number of PIs, etc.) on the research itself. The Committee was in favor of the Division moving into the new areas of biomolecular physics and chemistry, nanotechnology, and technology in support of human exploration and development of space, but cautioned against jeopardizing the investment in the other established research areas. The second phase of the report addressed the impact of the microgravity research on the field of which it is a part and the quality of the PIs in the program. The focus of the Division has been on combustion, materials, fluids, and fundamental physics. These elements have been re-structured into the five areas described by Dr. Trinh. The Committee looked through the research in the various areas, and the research satisfied the criteria. In response to a question by Dr. Silver, Dr. Voorhees cited some examples of the noteworthy results in combustion research (first ever stabilization of flame balls, structure of soot aggregates, fire propagation) and materials science research (theoretical work on pattern formation during solidification, dendritic growth in castings, applications to industry—liquid phase sintering). Dr. Shirley questioned whether the microgravity research program has been adequately publicized. One of the things that the Task Force is looking for is impact to society. In response to a question, Dr. Voorhees indicated that some experiments require extensive interaction with astronauts (flame ball experiment);

some are automated (dendritic growth experiment). The experiments and results that met the NRC criteria have been done on Spacelab. The degree of involvement of the astronaut is extremely experiment-specific. In response to a question, Dr. Trinh stated that the impact of physical sciences addresses the breadth of the scientific community—cross-disciplinary and multi-disciplinary. The contributions of the physical sciences would allow the development of new tools for the microgravity environment.

Dr. Acrivos reviewed the meta-analysis. There is a wealth of important information in the reports. One of the NRC reports, Setting Priorities for Space Research (1992), stated that NASA should support long-term, basic research. Another NRC report from 1995 (same subject) talked about the demand for applications-oriented research and technological development. The ISS Management and Cost Evaluation (IMCE) report stated that the highest research priority should be solving problems associated with long-duration human spaceflight, including the engineering required for human support mechanisms. A couple of SSB reports on microgravity research (1995 and 2000) had several recommendations on higher priority research subjects. The Division's prioritization is a combination of things that have been said before. Dr. Acrivos emphasized the fact that fluid mechanics (the fluids state of matter) plays an extremely important role throughout the biological and physical research programs. He indicated that it was unfortunate that the Task Force, due to time constraints, did not have the opportunity to have more presentations on the interesting research that has been done.

Closed session

The Task Force held a closed session meeting at this time.

Engineering Research Enabling Exploration

Dr. Trinh reviewed the OBPR prioritization and rationale for engineering research. The first priority is fire safety. This is a very important area of research. Propulsion and power is an area that OBPR would like to develop in connection with the Space Launch Initiative (SLI), focusing on the material research aspects. Biomolecular technology and sensors is a new program targeted towards developing miniaturized sensors for astronaut health. Radiation protection is strictly focused on developing materials and developing modeling codes. Mission resource production used to be in situ resource production (energy resources for an environment where there is no build-in capability). Dr. Shirley requested some elaboration on the rationale for the relative importance of the research area. Dr. Trinh indicated that fire can be a catastrophic event and we do not understand combustion processes in low gravity. This could be considered a "show stopper." Fire safety is a problem today and serious questions need to be addressed. Power and propulsion are future problems. Dr. Osborn questioned the basis on which projects in biomolecular technology and sensors were chosen. Dr. Trinh stated that the general goal is to develop general capabilities and have a fast track approach to technology directly applicable to NASA needs. The Task Force questioned "why NASA?" Dr. Olsen stated that in space, we will not be able to treat disease. In terms of long-term exploration, we want to be able to detect a disease before it becomes a disease. NASA is partnering with the NCI on this program. NASA's system engineering capability attracted the National Cancer Institute (NCI). Dr. Turek observed that this is something that should also be

done with DARPA and he encouraged OBPR to move in that direction. Dr. Ostrach emphasized that this is a ground-based program. Dr. Pawelczyk observed that there are elements in power and propulsion that would seem more appropriate for the Office of Space Flight (OSF). Dr. Trinh noted that the technologists in OSF and the Office of Aerospace Technology (OAT) have come to OBPR for the expertise that resides in the materials science community to help solve problems with them. Although we are looking for longer-range propulsion systems, the minimum time for a new material to make its way into a propulsion system is about 10 years. The fundamental work must be started now to meet those goals. Dr. Silver questioned why radiation protection was further down the list. Dr. Wargo replied that the type of work that is being done on the radiation shielding side concerns known physics that requires experimental verification. It is necessary to NASA, but may not be exciting new science. We are looking at incorporation of radiation shielding from the very beginning of the design phase. We are also looking at "dual-use" materials that are effective as shielding as well as new materials in spacecraft. Dr. Osborn noted that shielding seems to be the best solution to the radiation problem, which is a long-duration spaceflight "show stopper." In response to a question, Dr. Fogleman noted that ninety days stay is the top lifetime limit outside LEO. Within LEO, the stay time varies by age. Dr. Osborn added that there is very little data for outside LEO.

Dr. Viskanta reported on the meta-analysis. Details of his presentation were in the NRC report on microgravity research. It identified the technologies over the next 20 years, described the underlying physical phenomena, and made specific recommendations. High priority research areas were those arising in numerous Human Exploration and Development of Space (HEDS) technologies where gravity impacts physical phenomena: the physics of wetting and capillary driven flows (for welding); multiphase flow and heat transfer (for power production and utilization systems); fire phenomena (fire detection and suppression onboard); and multiphase system dynamics (reliable phase change systems). Dr. Viskanta discussed fluid physics as an example of a high priority area because it permeates fundamental microgravity, biotechnology, engineering applications, biological processes, human life support, thermal management, fire safety, power generation, and propulsion systems. Dr. Viskanta cited flow boiling heat transfer as an example of the intersection between interfacial phenomena and multiphase flow. The NRC considered the use of ISS for performing some of the long-term research (ref. Page 188 of the report). Although multiphase experiments could be performed on the Shuttle, the ISS offers an ideal opportunity for these types of experiments.

Closed session

The Task Force held a closed session meeting at this time.

Commercial Engineering Research and Technology Development

Mr. Uhran reviewed the OBPR prioritization and rationale for commercial engineering research. Virtually the entire program is performed on pallets on the ISS truss. The testbeds are reconfigurable. The Station affords the ability to service these on a regular basis in order to examine the experimental results, reconfigure the testbed, and retrieve the experiment. A core characteristic of this program is that all of the testbeds and

instruments are developed with private funds. A much shorter return on investment period is planned for these technologies. The ISS as a platform has not been available yet for this research. The testbeds are for the future. Investments are being made by both large and small companies. Criteria used to prioritize are net present value and breakthrough potential of the research. The rate-limiting step on progress has been access to space and the unpredictability of when the external sites will be available. Cost risk is a value. Interaction with the ISS is quite complex and getting a firm commitment on interfaces represents a high cost risk. With respect to remote sensing and autonomous systems, the single leading factor was moving the orbital inclination of the ISS to 53 degrees and changed the landscape for land-use applications. The cutting edge technology is hyperspectral imaging—the ability to take up to 256 separate bandwidths and collect data in each bandwidth. This opens up a wide variety of applications in many markets: vegetation indices (wood growth, disease vectors, agricultural), asset monitoring, environmental impacts, homeland defense, disaster assistance, and natural resource applications. The CSC for Engineering receives about $500 K for analytical tools, integration, etc. Communication is the second priority because bandwidth requirements are drivers. The current Station bandwidth is extremely limited. Commercial interest is being leveraged to look at two important technologies: phased-array antennas and laser optic communications (space to ground remains a challenge). These testbeds require the vantage point offered by the ISS. NASA's commitment to the commercial partners is both availability of the attach sites on the Station and a carrier that allows transport up and down and external accommodations. The carrier is planned under an international bartering arrangement with Brazil. Most external payloads require the carrier interface. NASA's goal is to advance the program to the point where the industry partner is paying for everything. The proprietary elements are owned by the host universities of the CSCs. Part of the strategy is to transition specific product lines out of the CSC cooperative agreement and into an agreement under the Space Act. The cost-leveraged cooperative agreement is an interim mechanism. Another aspect of communications is hybrid network communications. This has application in areas such as High Definition Television (HDTV) in space, with benefits to education and other commercial interests. There have been significant interim accomplishments. Thermal management (3rd category) involves a centrifugal device allowing a stable boundary between two phases. This has broad application to spacecraft. Power generation, storage, and distribution is the 4th category. Testbeds are required to advance PV systems. Another application is flywheel energy storage. This could lead to a $100 million private market. The next generation in space structures is lightweight structures with dual use applications. The last area is propulsion. There is industrial interest in ion propulsion systems (next generation technology for small spacecraft).

Dr. Osborn questioned the rationale on why this is in OBPR. Mr. Uhran indicated that the intent is to unite it with the CSC program, which is currently managed in this Division. Also, in many of the cases, the underlying scientific basis is in the Division. With respect to power, the work here represents an applied technology. All of these involve proprietary technologies because of the investments that the companies are making. The only way to review and evaluate these is to do it the way that a venture

capitalist would do it. When the technologies are perfected, they increase the capability of the Station and open up more capacity for utilization.

Dr. Bula reviewed the meta-analysis and the basis for the priorities. The priorities are an evolution from the NRC document on engineering and technology research on the Space Station (1996). The NRC encouraged the use of ISS as an engineering and technology research platform. This is why the CSCs decided that this is an area of importance and should be part of the commercial activity. The NRC report also recommended that NASA assist contractors in commercializing the technology they develop for the ISS program, and that measures should be taken to ensure that engineering and technology development on the ISS helps educate the next generation of scientists and engineers. The report primarily focused on the use of the Station as a testbed. Subsequent to that, there were various groups that developed priorities. In response to a question, Dr. Bula indicated that companies are currently putting money into evaluating concepts and estimating funds needed for experiments. Dr. Shirley requested that the Division provide the Task Force with some idea of the magnitude of the numbers.

Dr. Silver adjourned the open part of the meeting at 1:50 p.m.

Closed session
The Task Force held a closed session meeting at this time.

MEETING ATTENDEES

Task Force Members:

Silver, Rae *(Chair)*	Columbia University
Shirley, David *(Vice Chair)*	University of California, Berkeley
Acrivos, Andreas	City University of New York
Beachy, Roger	Danforth Plant Science
Bula, Raymond	University of Wisconsin, Madison
Jones, Noel	*[not affiliated]*
Lucid, Shannon	NASA/Johnson Space Center
Metcalf, Harold	State University of New York, Stony Brook
Morris, Partricia	DuPont Company
Oran, Elaine	Naval Research Laboratory
Osborn, Mary Jane	University of Connecticut
Ostrach, Louis *(Executive Secretary)*	NASA Headquarters
Pawelczyk, James	Penn State University
Pohland, Frederick	University of Pittsburgh
Roberts, Richard	New England Biolabs
Seddon, Rhea	Venderbilt Medical Group
Shirley, David	*[not affiliated]*
Stein, Gary	University of Massachusetts
Turek, Fred	Northwestern University
Viskanta, Raymond	Purdue University
Whitesides, George	Harvard University
Wiltzius, Pierre	University of Illinois
Zoloth, Laurie	San Francisco State University

NASA Attendees:

Ahlf, Peter	NASA Headquarters
Bartoe, John	NASA/JSC
Boudreaux, Mark	NASA/MSFC
Carlson, Ann	NASA Headquarters
Chambers, Larry	NASA Headquarters
Clinton, Corky	NASA Headquarters
Emond, John	NASA Headquarters
Erickson, Kristen	NASA Headquarters
Gillies, Donald	NASA/MSFC
Gonda, Steve	NASA/JSC
Guerra, Lisa	NASA Headquarters
Havens, Kitty	NASA Headquarters
Israelson, Ulf	NASA/JPL
Kundrot, Craig	NASA/MSFC
Larson, David	NASA Headquarters

Liskowsky, David	NASA Headquarters
Olsen, Kathie	NASA Headquarters
Pline, A.	NASA Headquarters
Rummel, John D.	NASA Headquarters
Shortz, Donna	NASA Headquarters
Siegel, Bette	NASA Headquarters
Uhran, Mark	NASA Headquarters
Wargo, Michael	NASA Headquarters
Weigel, Elsie	NASA Headquarters
Whitaker, Ann	NASA/MSFC

Other Attendees:

Gibbs, G.	CSA
Heppener, Marc	ESA
Jessup, J. M.	GUMC
Kamigaichi, Shigeki	NASDA
Koyama, Masato	NASDA
Pryke, Ian	ESA/Washington
Voorhees, Peter	Northwestern University

Meeting #3 Agenda
May 15 - 17, 2002

Wednesday, May 15, 2002

7:00 - Pre ReMAP Meeting Dinner at Cafe Grill in the Washington Court Hotel. Dinner will be served in the private Signature 2 room at the back of the restaurant. The Washington Court Hotel is adjacent to the Holiday Inn on the Hill at 525 New Jersey Avenue, NW, Washington, DC. - R. Silver

Thursday, May 16, 2002
Location: NASA Headquarters
300E St. SW
Washington, DC 20546
Room: 6H46 (MIC 6)

CLOSED SESSION

8:30 - 8:45	Review Agenda	R. Silver L. Ostrach
8:45 - 9:00	Report on Meeting with International Partners	R. Silver L. Ostrach
9:00 – 10:30	Terms of Reference Item 2d: Recommend modifications and/or additions to the OBPR research goals and objectives	R. Silver Task Force
10:30 – 11:00	Discussion with Administrator	S. O'Keefe
11:00 - 12:00	Revisiting Prioritization Rankings for: Energy Conversion, Materials Synthesis and Processing	E. Oran
	Clinical Health & Operational Medicine	R. Seddon
	Gravitational Ecology & Evolutionary Biology	J. Pawelczyk
	Cell Science & Tissue Engineering and Bioinspired & Microfluidics Technologies	G. Stein
	Protein Crystallography (Structural Biology and Commercial)	N. Jones
	Final Prioritization Ranking	R. Silver D. Shirley

12:00 - 1:00	Working Lunch	
1:00 - 3:45	Implementation Analysis: Presentation and Discussion; Discussion of 30%-30%-30% allocation of ISS Space	P. Ahlf
3:45 - 4:00	Discussion of importance of centrifuge (if necessary)	
4:00 - 4:45	Closing Remarks	S. O'Keefe
4:45 - 6:00	Terms of Reference Item 3: Increasing Science Productivity; Timely Access to Space	P. Ahlf
6:00	Adjourn	

Friday, May 17, 2002
Location: NASA Headquarters
300E St. SW
Washington, DC 20546
Room: 6H46 (MIC 6)

CLOSED SESSION

8:00 - 8:15	Review Agenda	R. Silver L. Ostrach
8:15 - 9:15	Terms of Reference Item 3: Increasing Science Productivity; Astronaut Perspectives	R. Seddon J. Pawelczyk S. Lucid
9:15 - 10:15	Terms of Reference Item 3: Increasing Science Productivity: Optimal models for solicitation and review of science proposals	R.Silver Task Force
10:15 - 11:00	Break	
11:00 - 11:30	Terms of Reference Item 3: Increasing Science Productivity; Discussion of Science Metrics/ Review of Current Metrics	M. Wargo
11:30 - 12:00	Discussion - Task Force	
12:00 - 2:00	Lunch: Writing of ReMAP Slide Presentation to NAC	A. Carlson L. Ostrach R. Silver D. Shirley Others
2:00 - 6:00	Writing/review of ReMAP Presentation to NAC	R. Silver D. Shirley A. Carlson Task Force Code U staff
6:00	Adjourn	

MEETING ATTENDEES

Task Force Members:

Silver, Rae (Chair)	Columbia University
Shirley, David A (Vice-Chair)	[not affiliated]
Acrivos, Andreas	City University of New York
Beachy, Roger	Danforth Plant Science Center
Bula, Raymond	[not affiliated]
Jones, Noel	[not affiliated]
Lucid, Shannon (NASA Liaison)	NASA/JSC
Morris, Patricia	Dupont Den Nemours & Co., Inc.
Oran, Elaine	Naval Research Laboratory
Osborn, Mary Jane	University of Connecticut
Ostrach, Louis (Executive Secretary)	NASA Headquarters
Pawelczyk, Jim	Pennsylvania State University
Pohland, Frederick	University of Pittsburgh
Seddon, Rhea	Vanderbilt University
Stein, Gary	University of Massachusetts
Turek, Fred W.	Northwestern University
Viskanta, Raymond	Purdue University
Wiltzius, Pierre	University of Illinois
Zoloth, Laurie	San Francisco State University

NASA Attendees:

Ahlf, Peter	NASA Headquarters
Carlson, Ann	NASA Headquarters
Guerra, Lisa	NASA Headquarters
Kicza, Mary	NASA Headquarters
O'Keefe, Sean	NASA Headquarters
Olsen, Kathie	NASA Headquarters
Penley, Ned	NASA/JSC